SOME STRATIGRAPHIC AND STRUCTURAL FEATURES OF THE PRE-CAMBRIAN OF NORTHERN QUEBEC

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PART IV

DIASTROPHISM

The evidence cited in the preceding pages indicates that previous to the end of the period of deposition of the Mattagami series no general orogenic movements took place in this region, but that such movements as occurred were of the gentle, epeirogenic type. After the deposition of the Mattagami series, intense orogenic movements went on, which folded the Mattagami and Nemenjish series and the Abitibi volcanics closely, and converted a large proportion of them into schists. By some writers this folding has been supposed to have accompanied the intrusion of the granite, and been caused by the hydrostatic pressure of the upwelling magma. Were this the case, the remnants of the older series should have dominantly synclinal or monoclinal structures, and there would be no general correspondence between the axes of the folds of the different remnants. Such a condition appears to obtain in the Grenville-granite complex in the Adirondacks, according to W. J. Miller.[1] However, it does not appear to be the case throughout Ontario and Quebec, where no dominantly synclinal or monoclinal structure exists, and where there appear to be a definite subparallelism of the axes of folding over considerable areas.

A tabulation of the areas which have been discussed, with their general structure and the strike of their axes of folding as nearly as determinable, is given on page 368.

The parallelism of the axes of folding of the different, rather widely separated areas is remarkable. All, it will be observed, fall within between N. 75° E. and S. 70° E. As the folds are

[1] W. J. Miller, *Jour. Geol.*, XXIV (1916), 587.

probably to be considered only as secondary folds on the flanks of the large regional major folds, parallelism is not to be expected between them, as the strike of the axes of such secondary folds is governed by the general strike of the strata at the point where they occur. The extension of data of the foregoing type over a large region will enable the nature of the great regional folds to be worked out; but this cannot be done now, as the area under discussion, though large, is small compared with the size of the Labrador peninsula.

Area	Structure	Strike of Axis
Kenoniska	Anticline	S. 75° E.
Lucky Strike	Anticline	S. 75° E.
Brock	Anticline	N. 85° E.
Opawika	An-Sy-An	N. 75° E.
Father's Lake	Syncline	S. 75° E.
Windy Lake	Monocline	E.-W.
Nemenjish	.....	N. 60° E.
Eau Jaune	.....	S. 70° E.
Mattagami	Probable anticline	N. 80° E.
Pontiac	Probable anticline	E.-W. E.

The general parallelism of axes indicates that the regional folding was not caused by the hydrostatic pressures of batholithic intrusions, but by a compressive stress affecting large areas uniformly; while the lack of shear in the granites shows that the folding occurred before their intrusion. This conclusion does not of course invalidate the possibility that the intrusions followed the folding very closely.

The folding may therefore be dated as post-Mattagami and pre-batholithic. It resulted in the formation of close folds with an east-west axial trend and cross folds of a much more open type. The cross folding has given a plunge of some 20° to the axes of the major folds.

In addition to the post-Mattagami folding movement, some evidence exists that there was an earlier folding, affecting not the region under discussion, but that to the south, the borders of the continental segment, in Grenville time. This accompanied or closely followed the intrusion of the earlier granite, but preceded the intrusion of the anorthosite. In the Adirondacks, Cushing,[1]

[1] *Reports of the New York State Museum.*

Kemp, and Smyth describe the Grenville series and older granite-gneiss as much more metamorphosed than the intrusive anorthosite, a fact which may indicate an early folding, but may also be due to the greater competence of the anorthosite to resist the later folding. The evidence is slight, but it is very possibly the case that the marginal intrusion of granite accompanying the uplift of the Grenville continental segment at the close of Grenville time was accompanied by marginal folding movements. If this is true, we should expect to find in these districts the equivalents of the Mattagami series resting with structural as well as erosional unconformity on the Grenville. This seems to have been the condition in the Madoc district, where according to Miller the Hastings series, a possible equivalent of the Mattagami series, rests against the upturned edges of the Grenville.[1]

GRENVILLE (?) SEDIMENTS ON THE WEST SIDE OF HUDSON BAY

While no sediments that can be definitely asserted to be of Grenville age have as yet been described to the west of Hudson Bay, it is interesting to note that there are a number of areas of rocks whose petrography is similar to that of the Grenville series, and which, like them, are intruded by granite apparently of very great age. The reports of Tyrrell and others in this region have yielded a number of more or less doubtful occurrences of these rocks. A few others have been described to the writer by present members of the staff of the Geological Survey. In the vicinity of Lake La Ronge, W. McInnes has reported[2] crystalline limestones and basic intrusives, greatly folded and altered, and intruded by the granite gneisses of the district. E. L. Bruce has informed the writer that he found ancient garnet and staurolite gneisses intruded by granites around Wekusko Lake, Manitoba. One of the gneisses analyzed is undoubtedly of sedimentary origin. Tyrrell, studying this same area, reports that this gneiss "grades downward into the greenstone schists"; apparently indicating a conformable relation between the two, similar to that described in this paper. F. J. Alcock states that to the northeast of Lake Athabaska he found an

[1] *Rept. Ont. Bur. of Mines*, Part 2, 1914, p. 12.

[2] *Geol. Surv. Can. Mem. 30*, 1913, p. 48.

area of garnetiferous mica gneisses, intruded by granites. The occurrence of such sediments is of great interest, as indicating the possibility of future correlation with the eastern side of Hudson Bay.

THEORETICAL CONSIDERATIONS

Conditions of Extrusions of Abitibi Volcanics

The nature of the floor upon which the Abitibi volcanics were poured out cannot be more than a matter for conjecture. No trace has as yet been found of the rocks which once composed it, to show whether they were sedimentary or igneous, flat-lying or folded. Other facts are, however, more certain.

In the following section the conclusion is drawn from a consideration of the nature of the Grenville sediments that the Grenville series in the interior of Quebec was deposited under continental or shoal-water marine conditions. The region was therefore a continental plateau, or positive element, even at this time. As evidence is lacking of the occurrence of any great earth movement between the extrusion of the Abitibi volcanics and the deposition of the Grenville series, it would be reasonable to conclude that during the extrusive period also the region must have been a positive element. Some direct evidence on this question is obtainable from the lavas themselves, using pillow lavas and bedded tuffs as criteria of subaqueous extrusion.

On Obatogamau Lake all the lavas, even the basal basalts, show pillow structures. On Kaopatina Lake and eastward to Father's Lake, the basalts are not pillowed, but the overlying lavas have the structure well developed, and interbanded tuffs are well bedded. On Tush Lake and the areas to the northward, none of the lavas are well bedded. While this line of evidence has not been worked out in detail throughout the entire area, the facts obtained suggest that the extrusive period was one of gradual submergence. The earliest recognized shore must have lain between Obatogamau and Kaopatina lakes, and a westward transgression of the sea took place thereafter. The submergence evidently went on after the extrusion of the lavas was complete, since garnetiferous gneisses

identical with the rocks of the Grenville series are found up to the shores of James Bay.

Alternative to the hypothesis of marine transgression lies the possibility that at this time the land was covered by a series of large lakes. If the land remained above the level of the sea, the outpourings of lava that took place must have filled the stream valleys and utterly disorganized the drainage; lakes must have been formed as a result, and if the region was one of low relief, as it will presently be shown appears probable, these lakes may have attained sizes comparable to those of the great glacial lakes of Pleistocene times. Such a condition would explain the facts stated, as well as marine transgression.

Topographically, the surface on which the lavas were poured out seems to have been one of low relief. Had high mountains existed at the time, the remains of the peaks, around which the lavas would have flowed, should surely be found now penetrating into at least the lower beds above, which are now on edge. Nothing of the sort has come to light. Again, had the extrusions been thrown out from high peaks, such as the volcanic cones of the present day, we might now expect to find sudden changes of strike near the volcanic centers, due to the occurrence of steep depositional dips. This has not been observed. The conclusion may therefore tentatively be drawn that the flows were extruded as fissure eruptions, at least in the case of the more widely distributed basic lavas, and to have flowed out over a surface of fairly low relief. More detailed field work is necessary, with careful mapping of the areal boundaries of separate flows, to establish this conclusion.

Conditions of Deposition of the Grenville Series

Areal distribution.—A careful search has been made of the reports of the explorers of northern Quebec and Labrador, and determinations made from their descriptions of the location of areas of the Grenville series, using as criteria for its determination mainly petrographic similarity and geological relations. Many descriptions were met with of rocks which bear a strong resemblance to certain phases of the Grenville, but are likewise indistinguishable from the Pontiac or some other highly altered sedimentary series.

These are not included on the accompanying map; the bodies mapped are confined to those highly garnetiferous types, with or without limestone, which are peculiarly characteristic of the

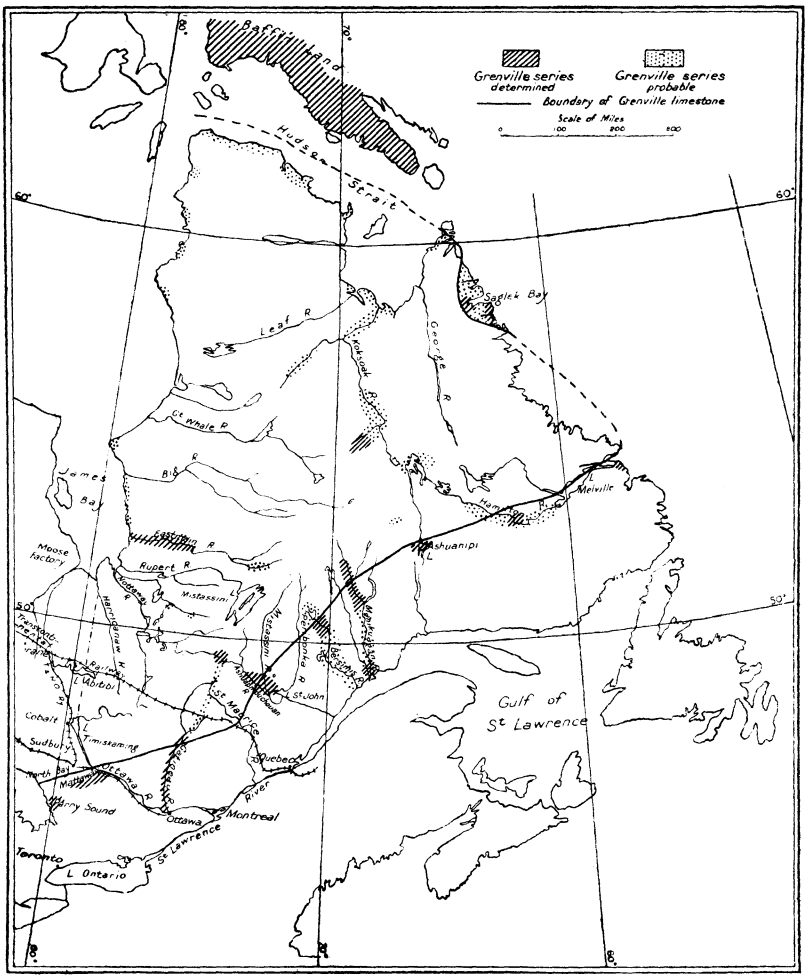

FIG. 13.—Map to illustrate the distribution of the limestone member of the Grenville series. Limestone is absent on the Hudson Bay side of the heavy black line and present on the southeast side.

Grenville. The areas shown on the map (Fig. 13) are those in which the amount of the Grenville series present is so large and its

characteristics so definite that its identification can scarcely be doubted. The dotted patches are those in which the amount of Grenville present, relative to that of the granite which has intruded it, is small, so that its identification is more open to argument. Even in these cases, however, the effort has been made, as stated, to weed out the doubtful cases and include none but those in which identification is fairly certain. The results show the presence of the Grenville over the whole interior of the Labrador peninsula, wherever exploration has been carried, as well as in Baffin Land and the long-known districts to the south.

The study of the older reports, together with the writer's own field work, has brought to light a peculiarity in the distribution of the limestone member of the series. Limestone is found in Baffin Land, in places along the Labrador coast, and throughout southern Quebec and Ontario, as well as in the Adirondack region; but little or no limestone has been described throughout the interior plateau of northern Quebec. It has been considered by certain authors that the lack of limestone in this region is due to its solution by the intrusive granite, where the granite is present in sufficiently large amount. This opinion does not appear to be well founded. In the section northward along the Gatineau River, above the town of Maniwaki, the writer found that the limestone member decreases in relative amount, with corresponding increase of the clastic members of the series, until it disappears altogether, without any notable increase in the amount of intrusive granite which is present throughout in considerable amount. In the Nemenjish area, there are at least several hundred feet of clastics, entirely free from intrusive granite. With them there are interbedded only two bands of limestone, each about a foot in thickness. These facts seem explicable only on the hypothesis that the limestone never was deposited in the localities mentioned; in other words, the lack of limestone in certain areas is due mainly to a primary difference of sedimentation rather than to removal after deposition by the granite. A preliminary attempt has been made, from a study of the reports, to determine the position throughout the Labrador-Quebec region at which this change in sedimentation took place, and to indicate it on the map (Fig. 13) by a heavy black line. On the Hudson Bay side of this line little or

no limestone has been found, but on the other side of the line limestone in considerable amount.

The existence of such a definite boundary is of great significance in considering the conditions of deposition of the Grenville series. We have an interior region in which, for some reason, conditions were unfavorable for the deposition of limestone; while, beyond the margins of this region, limestone was deposited freely. Two possibilities present themselves to explain this fact. The portion of the Grenville within the limestone boundary may be of terrestrial origin, in which case the limestone boundary will represent approximately the location of the Grenville shore line; or the whole series may be marine, but the clastic sediment within the limestone boundary may have been so abundant that limestone was not formed there. In either case the limestone boundary represents a topographic break, where an interior plateau fell off sharply to a lower level. The solution of this problem therefore depends on the determination of the marine or non-marine origin of the Grenville sediments within the limestone boundary.

The data at hand are not sufficient for the solution of this problem, since the comparatively small Nemenjish area is as yet the only one which has been studied. The known facts, pro and con, may be summarized as follows:

A. In favor of a non-marine origin of the series where limestone is absent:

1. The Nemenjish sediments as a rule have the composition of an altered greywacke as if derived from older rocks by disintegration without much decomposition. They show small variations in mineral composition, but these variations appear to be due to variation in the composition of the older rocks from which they were derived, rather than the variations due to normal weathering and consequent separation into sandstone and shale constituents. True quartzites, shales or slates, and limestones are conspicuous by their absence, or their presence in very small amount, in the northern region, although they are present in greater amount in the marine division of the series beyond the limestone boundary—a natural result of transportation over greater distances.

2. Although remnants of the Grenville sediments appear to be scattered over the whole of the Labrador plateau, it is not yet proved

that they once formed a continuous sheet over this area. It is equally possible that they may have been deposited in discontinuous basins.

3. If the origin of the sediments was marine, a study of the map shows that it will be necessary to postulate that the land area from which they were derived occupied part of the present area of Hudson Bay. It is difficult to conceive of the transport of sandy sediments from a land area in this position to the eastern Ontario district or the Labrador coast.

B. In favor of a marine origin:

1. The entire lack of conglomerates or coarse-grained clastic sediment in the known portions of this series is strongly against the hypothesis of a non-marine origin. Deformation has not been so great as to destroy such textures, as their preservation in the Mattagami series shows.

2. In the Nemenjish area all the rocks are well bedded, usually in beds twenty or more feet in thickness. No trace remains of cross-bedding, lens-shaped beds, or other structures characteristic of terrestrial deposits. This area might of course have been part of the site of a large lake.

3. The greywacke-like composition of the rocks might equally well be explained on the basis of the lack of vegetation in these early times, so that the composition might not argue either for or against the marine origin. Where vegetation was lacking and precipitation abundant, sediment would be removed as fast as disintegration took place, so that complete decomposition of the rock constituents by weathering might not have taken place.

Conditions of Deposition of the Mattagami Series

Areal distribution.—The Mattagami series is not known certainly outside of the region under discussion, as its existence and age relations have been recognized only within the last few years. Apparently, however, it was once fairly uniformly distributed over northwestern Quebec, at least as far north as the East Main River, where sediments of similar composition and degree of deformation are described by Low.[1] The writer has not been able to identify the

[1] *Geol. Surv. Can., Ann. Rept.*, VIII (1896), Part L.

series elsewhere in northern Quebec from the reports. The Timiskaming, Sudbury, and Hastings series to the south and southwest may possibly be of the same age, though a definite correlation cannot now be made.

The same difficulties obtain in the Mattagami series as in the Grenville series with regard to a marine or non-marine origin. Generally speaking, the composition of the two series is very similar, that of an altered, rather impure sand, implying conditions of rapid weathering and deposition without extended decomposition of the rock constituents. All the arguments for and against a marine origin that have been previously cited in the case of the Grenville hold also in the case of the Mattagami series, with the exception that the Mattagami series includes a heavy basal conglomerate of such thickness that a non-marine origin for this member at least seems very probable. In the Lucky Strike area, where the series has been greatly thinned by shearing, the present thickness of the conglomerate band is approximately 300 feet. In the Kenoniska area there are two bands of conglomerate, separated by a thick, massive, basic greywacke, with very little trace of bedding and holding an occasional pebble. The thickness of the whole is very difficult to estimate on account of the probable thickening of the formation at the nose of the fold by flowage, and uncertainty as to the plunge of the fold. A minimum estimate by the writer, however, yielded a thickness here of at least 1,000 feet. According to Barrell, marine conglomerates are rarely over 100 feet in thickness. If this is true, the conglomerate member of the Mattagami series is probably of non-marine origin.

Diastrophism

Certain considerations seem to indicate that the great diastrophic movements which followed the deposition of the Mattagami series were connected with, or resulted in, the primary formation of the great geosyncline of Hudson Bay. These may be summarized as follows:

1. If the Nemenjish and Mattagami series are considered to be marine formations, their distribution indicates that the only possible land mass which would supply the necessary sediments must have occupied the present position of Hudson Bay.

2. Leith[1] has shown that the formation of the great Lake Superior syncline began in pre-Keweenawan time, and suggests indirectly that it may have begun to form very much earlier, even in the pre-Huronian. The formation of a structure of this size must have been accompanied by profound deformative effects on the rocks for a long distance to the north and south. The evidence from the parts of northern Ontario and Quebec dealt with in this paper indicates that they have been affected by only one intense folding movement of pre-Keweenawan age, the post-Mattagami movement. The Bruce series, or Lower Huronian of the north shore of Lake Huron, and the Cobalt series which overlies it, where not affected by Keweenawan deformation are only gently folded and rest on a folded and peneplaned surface. It seems reasonable therefore to correlate the post-Mattagami folding with the primary formation of the great synclines of Lake Superior and Hudson Bay. The region between, under this hypothesis, is an anticlinorium, and was probably mountainous, so far as can be judged from estimates of the thicknesses of rock removed during the pre-Huronian peneplanation.

3. The Nastapoka sediments on the east shore of Hudson Bay are classified by Leith[2] as of Keweenawan age, with perhaps some Animikee rocks included. The presence of these rocks shows that at this time Hudson Bay was already a synclinal depression in which sediments were being deposited. Their deformation shows, in addition, that the folding movements by which it was formed were still going on. This history is parallel to that of the Lake Superior basin, the deformation of which continued throughout pre-Cambrian time up to the end of the Keweenawan.

REGIONAL HISTORY

In the earliest times of which we have record the northern Quebec region appears to have been a continental plateau of low relief. This plateau included not only northern Quebec, Labrador, and probably Hudson Bay, but also Baffin Land, eastern Ontario, parts of New York and Vermont, and perhaps a large area to the

[1] *U.S. Geol. Surv. Monograph 52* (1911), p. 622.

[2] *Economic Geology*, V (1910), 227–46.

west and southwest of Hudson Bay. What its further extent may have been is not known. The nature of the rocks that composed the plateau and formed the floor on which later rocks were laid down is yet unknown. The first event of which record remains is the extrusion of vast amounts of lavas, which spread in sheets over the greater part of it. Many of these lavas possess pillow structures and are interbanded with beds of tuffaceous sediments. Both of these lines of evidence indicate subaqueous extrusion; so that either the sea covered portions of the plateau at this time or the earlier extrusions of lava so disorganized the drainage as to create large lakes, in which ellipsoidal lavas and bedded tuffs were laid down. In the northern Quebec district the oldest lavas found are of basaltic composition. They were succeeded by more acid types as extrusion went on, so that the basalts are overlain successively by porphyritic basalts and andesites. Between the andesite flows, beds of chert are occasionally found, which probably represent portions of the load of magmatic waters accompanying the flows. Near or at the top of the andesite flows, beds of coarse tuff are found locally, indicating that the period of andesite extrusion ended with volcanic explosions. The period of volcanism closed with a number of local and small extrusions of quartz porphyry. In places this porphyry forms a breccia instead of a massive flow. The brecciated texture has been shown to be due porbably to subaqueous extrusion, and thus corresponds to the pillow structure in the more basic lavas.

At the close of the extrusive period deposition of sediments began. The lowest beds are of a rather basic, tuffaceous composition. These beds soon give place to others which have more the composition of impure sands and are now altered to micaceous schists containing a few garnets. Higher in the series a further change in composition takes place, probably by an increase in the lime content of the beds, which is marked by the appearance of garnets in great numbers. Interbedded with the garnetiferous mica gneisses are beds of garnetiferous hornblende gneiss and an occasional thin bed of crystalline limestone. These sediments, locally termed the Nemenjish series, are correlated with the Grenville series. It is as yet uncertain whether they are to be con-

sidered as of marine or of terrestrial origin. They are separated by a fairly sharp boundary from the known marine portion of the Grenville to the south, in which much limestone is found. This boundary represents approximately the position of the ancient shore line, if the sediments to the north are of terrestrial origin; if the sediments to the north are marine, it represents a topographic break, separating an area of very shoal water deposition to the north from an area of deeper water deposition to the south. In the latter case, the sediments of the Grenville must have been derived from a land area occupying the site of Hudson Bay.

At the end of the Grenville period of deposition, uplift appears to have taken place, and a period of erosion ensued. This was sufficiently long to remove all or the greater part of the Grenville series from much of the interior plateau, where presumably it was thinnest, since in the area between Lake Mistassini and James Bay the supposed Grenville has been found in only two places between the lavas and the Mattagami sediments.

The emergence just described appears to have been accompanied or closely followed by intrusions of granite in the southern portions of the plateau. This "older granite" has not yet been recognized farther north than Lake St. John. There is some evidence to show that folding movements also accompanied these granite intrusions, causing deformation of the rocks of the southern edge of the plateau. After the intrusion of the granite and the folding movements, if any, were ended, masses of anorthosite and feldspathic gabbro were intruded. These have been found as far north as Lake Chibougamau, but are more numerous and larger in the southern districts, where the earlier granite occurs. The localization of two such widespread intrusions within similar limits is probably due to some common cause; perhaps to the presence of lines of weakness in the older rocks caused by the folding just mentioned. No important orogenic movement appears to have accompanied the anorthosite intrusion.

The next event in the history of the region was the deposition of the Mattagami series, which may or may not have been accompanied by marine submergence. The thickness of the basal conglomerate of the series indicates that at least this member probably

accumulated under non-marine conditions, if Barrell's conclusion as to the thickness of marine conglomerates is to be accepted. The deposition of the conglomerate was followed by that of thick beds of arkose and greywacke, locally with a little quartzite. A limestone member may have been present in beds laid down beyond the southern margin of the interior plateau.

Following the deposition of the Mattagami series came a period of intense orogenic movement and mountain-building, during which all the rocks were folded closely along east-west axes and gently along north-south axes. The more incompetent rocks were converted into schists. Following the folding was the great intrusion of later granite, which stoped away and digested vast quantities of the older rocks, and which, now exposed by erosion, underlies the major part of the region.

A period of erosion followed, so long that the mountains of the last folding were cut down nearly to base-level, and the granite batholiths laid bare. No recognizable trace has yet been found of the sediments which resulted from this erosion and which must have been deposited somewhere during this period. The next event of which any record remains is the deposition of the Bruce series on the peneplained surface of the older rocks on the north shore of Lake Huron. This indicates a third period of submergence, which appears, however, to have been of small areal extent. Emergence and the erosion of about 1,600 feet of the Bruce series followed, with further gentle folding, after which a more extensive submergence initiated the deposition of the Cobalt series. At this time the sea transgressed certainly as far northward as Lake Abitibi, and possibly to Lake Mistassini and beyond. The nature of the Cobalt sediments indicates that the sea was probably very shallow. Glacial conditions obtained at this time, according to Coleman, M. E. Wilson, and others, and influenced the character of the sediments laid down. The final event in the history of the region, so far as traced here, was the intrusion of gabbro and diabase into the older rocks in sills and dykes, preceding or accompanying further gentle folding movements.

Climate and life.—Our knowledge of the climate and life conditions that prevailed in these early times is exceedingly scanty,

and all of it so inferential that it is of small value. The presence of the great thicknesses of limestone in the Grenville series is, however, strongly suggestive of the existence of lime-precipitating organisms even at that early period, although it is of course conceivable that the precipitation of lime at that time may have been chemical. The common presence of scales of graphite in the quartzite and crystalline limestone and the also common presence of H_2S apparently included in the limestone crystals are, however, both rather strongly corroborative of an organic origin. Whether life extended to the land at this time is more doubtful. If it did, it must have been of a very sparse nature, with little restraining effect on the movement of soils under erosive influences. The nature of the clastic sediments that were deposited throughout Grenville and Mattagami time indicates conditions under which the soil was removed from the land surfaces without the prolonged weathering and thorough decomposition of the mineral constituents that a good covering of vegetation promotes.

The climate of the Grenville period may be inferred to have been mild for the following reasons: (1) If the limestone of the series is of organic origin, it would imply the existence of a warm epicontinental sea. (2) The Grenville sediments, though not well weathered, are as a rule much more acid than the basic lavas from which in all probability they were largely derived. This would indicate, in the absence of vegetation, a warm climate favoring the rapid decomposition of the rock constituents. (3) The enormous extrusions of lava which took place preceding the deposition of the Grenville must have been accompanied by the exhalation of huge volumes of carbon dioxide into the atmosphere. The presence of this carbon dioxide may have had some effect in ameliorating the climate of the period.

The climate during the Mattagami period is more in doubt, but it was probably cooler than that of the Grenville period. The presence of limestone in very small quantities only might suggest a sea colder than that of Grenville time, in which lime-secreting organisms did not exist in such profusion. The clastics, though frequently similar to the Grenville, are in general more basic and less weathered. This might also indicate colder climatic conditions.

SUMMARY

This paper first describes methods which the writer has used for the determination of structure in the volcanic flows, often termed "Keewatin," that form the oldest known rocks of northern Quebec. These methods, applied to four areas of these volcanics on the Opawika River, a tributary of the Nottaway, have resulted in the determination of a similar sequence of extrusion in each area. The sequence is one of increasing acidity, and consists of basalt at the base, overlain successively by feldspathic basalt characterized by large phenocrysts of feldspar, andesite, dacite, and rhyolite. All members of this series are not necessarily present in any one locality, but their succession when present is invariable as stated.

The paper also establishes the occurrence in northern Quebec of two important sedimentary series, both apparently of pre-Huronian age. One of these, the Nemenjish series, has been found by the writer in one locality only. It consists of a series of garnetiferous gneisses, mainly the recrystallized form of impure sandstones, which still exhibit bedding and other characteristics of sediments. The rocks rest with structural conformity on the surface of the ancient lavas, and some evidence is given to show that they probably are to be correlated with the Grenville series. The other sedimentary series, the Mattagami, has been found in five different areas. Evidence based on the character of the sediments in each area, the sequence of the formations in each series, the structures, and the relations to older and younger rocks, is cited to show that they are all of one age. The evidence relating to their position in the geologic column is less satisfactory, but they appear to overlie the Nemenjish series with unconformity, and to be much older than the Lower Huronian, or Bruce series.

In addition to these matters of principal interest, the paper discusses a number of theoretical considerations. One of these may particularly be mentioned. The explorations of northern Quebec show the existence of a fairly sharp boundary line, on one side of which limestone is a member of the Grenville series, while on the other side it does not appear. The significance of this line is discussed, and the conclusion reached that it represents an ancient topographic break, either a shore line or the boundary of a submerged plateau.